The synopsis of the proposed research work entitled

Studies on structural, optical and γ–rays absorption properties of high Z element doped CdS thin films

Submitted to

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To be submitted by

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Doctor of Philosophy

In Physics

(Faculty of Science and Technology)

Under the guidance of

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Format for submission of Ph.D. Synopsis / Work plan for faculty of Science to be submitted in front of RRC

Title: Studies on structural, optical and γ–rays absorption properties of high Z element doped CdS thin films

Abstract of proposed work plan / problem:

It is proposed to study the thin films for protecting the human beings from radiations from thin films with high Z elements. To study the variation of structural, optical and γ–rays absorption properties of Cadmium sulfide (CdS) thin films doped with different elements and to study the effect of their doping concentrations on these properties. We planned to synthesis of CdS thin films doped with different elements like Tin (Sn), Lead (Pb), Zinc (Zn) and Lanthanum (La) etc. The prepared thin films will be characterized by using different characterization techniques such as γ–rays absorption spectometer, XRD, EDAX and UV-Visible spectrophotometer. It is also planned to fabricate the active electronic device.

1. Introduction:

The structural and optical studies will be undertaken for analysing their structural, optical and γ–rays absorption properties by using X-ray diffractometer (XRD), Energy Dispersive Analysis by X-Rays Measurement (EDAX) and UV-Visible spectrophotometer of experimental thin films. The study will be reported for different doping elements. It is also planned to study the electrical resistivity of the prepared thin films. The variation of electrical resistivity with temperature is to be investigated. The thermoelectric power (TEP) will be determined by using TEP measurement device to determine the thermal activation energy and to report the information about the type of carriers in the prepared semiconducting thin films.

Thin films will be irradiated for different gamma rays energies and their change in characterization will be observed. The CdS thin films will be deposited on bare glass substrates by evaporation method. The necessary deposition parameters will be optimized in initial phase to yield good quality, adherent and stoichiometric thin films. The contents of CdS thin films will be varied by using different doping elements like Tin (Sn), Lead (Pb),

Zinc (Zn) and Lanthanum (La) etc. and their compositions, for studying the growth mechanism and reaction kinetics.

2. Review of Literature and Development in the subject (Previous work done in the relevant area):

- Zeynep Deniz Eygi et al.(2016) studied Sn doped thin films and investigated the effect of the Sn dopant on the optical, structural and electrical properites of CdS films. The electrical analysis proved the improvement in resistance by increasing Sn dopant atoms in CdS lattice.
- Rajaram S. Mane (2016) studied the crystal structure of TiO_2 nanoparticles. Some changes improved the solar to electrical power conversion efficiency of solar cells.
- Betkar M.M.and Londhe C.T. studied the $CdCl_2$ based CdS films. They studied the effect of substrate temperatures on the optical properties of synthesized thin films.
- U.V. Biradar and M.M. Betkar studied morphological characterization of CdxZn1-xS thin films. They shown that Zn doping has significant effect on surface morphology of thin films.
- Ravangave L. S., Biradar U. V. and Misal S. D. prepared cadmium zinc sulfide (CdxZn1-xS) thin films on glass substrate using spray pyrolysis chemical deposition technique and studied the effect of Cd composition on structural and optical properties.
- Devices E. (2012) prepared Nitrogen doped p type ZnO films by a simple and low cost spray pyrolysis technique for various precursor solution concentrations with air as carrier gas. The optical constants such as refractive index (n) and extinction coefficient (k), band gap, and the electrical properties of the prepared thin films were measured.
- Jafarov M.A.and Nasirov E.F. (2012) described a new technology of chemical surface deposition and prepared CdTe thin films (35-100 nm) on the CdZnS substrates. They have been investigated the electrical and photoelectric properties of CdZnS /CdS /CdTe hetero-junctions, as well as the possibility of using the method of chemical surface deposition of CdTe to create thin-film CdZnS/CdTe solar cells.
- Sanap V.B.and Pawar B.H.(2011) studied Cd1-xZnxS thin films grown on commercial glass slide substrate by chemical bath deposition technique at 70 ± 2 ºC. The effect of zinc content (x value) on structural, morphological and some optical properties have been studied. The As-deposited Cd1-xZnxS thin films were

characterized using X-ray diffractometer (X- PERT PRO), SEM and UV-VIS spectrophotometer.

- Arturo Morales-Acevedo (2006) studied polycrystalline thin film Cadmium Telluride (CdTe) ,analysed the typical CdS/CdTe superstrate solar cell and from it they also shown that present record efficiencies are very close to the practical efficiency limit for a CdS/CdTe hetero-junction cell.

3. Objectives of Research/ Proposed Hypothesis :

- To grow CdS thin films doped with different elements like Tin (Sn), Lead (Pb), Zinc (Zn) and Lanthanum (La) etc. using evaporation method.
- Thin films grown by evaporation method are used to study their structural, optical and γ–rays absorption properties.
- To report the innovative findings beneficial for human beings.

4. Methodology to be adopted:

a) Introduction:

The CdS thin films will be deposited on bare fabric material by spray pyrolysis technique. The necessary deposition parameters will be optimized in initial phase to yield good adherent stochiometric thin films.

Cadmium sulfide, CdS is a (II–VI) compound semiconductor. It has found potential applications because of its wide and direct band gap (2.42 eV) at room temperature, good optical transmittance, low resistivity and easy ohmic contact.

In particular, thin films of n-type CdS (Cadmium sulfide) are widely used as a window layer in hetero-junction realization of p-type CdTe(Cadmium Telluride). Hence, a large number of studies have been carried in order to produce thin films of CdS material with suitable optoelectronic properties for photovoltaic applications.

For this purpose, several properties are required for the CdS films:

(i) Relatively high transparency, not too thick to favor the absorption in the CdTe absorber layer.

(ii) Not too thin to avoid the short circuiting.

(iii) Relatively large conductivity to reduce the electrical solar cells losses and higher photoconductivity to not alter the solar cell spectral response.

Several methods have been used to prepare CdS thin films namely:

(a) Evaporation method

(b) Spray Pyrolysis method and

(c) Chemical Bath Deposition method

Among these, evaporation method is one of the most well known method. It is simple and one can evaporate a large variety of materials (metals, semiconductors or insulators) on different types of substrate. In evaporation method, the evaporation is carried out at low pressure or high vacuum (~ 10^{-6} Torr).

The physical properties of the films prepared by evaporation method depend on many factors such as film thickness, substrate temperature and deposition rate. Furthermore, the crystallites and impurities incorporated during the deposition process strongly affect the electrical, structural and optical properties of the deposited films.

It is well known that CdS thin films can exist in either cubic or hexagonal phase or as a mixture of both the phases depending on the deposition condition. In the present study, CdS thin films are deposited by evaporation method at different substrate temperatures and the films are characterized by several techniques such as X-ray diffraction(XRD), Transmission Electron Microscopy(TEM) and optical transmittance. Also the effect of substrate temperature on the structural, optical and electrical properties is discussed and further thin films are irradiated for different gamma rays energies.

b) Experimental details:

In evaporation method, an electric resistance heater is used to melt the material and raise its vapour pressure to a useful range. This is done in a high vacuum, both to allow the vapour to reach the substrate without reacting with or scattering against other gas-phase atoms in the chamber, and reduce the incorporation of impurities from the residual gas in the vacuum chamber. Obviously, only materials with a much higher vapour pressure than the heating element can be deposited without contamination of the film.

Cadmium sulfide thin films will be prepared by evaporating pure crystal on well-cleaned bare glass substrates. The films will be grown at different substrate temperatures. The structural properties of CdS films grown by evaporation method will be examined by the X-ray diffraction method (XRD).Optical properties of CdS films grown by evaporation method will be measured with the different wavelengths at room temperature. The electrical resistivity of the films will be measured at room temperature. The surface morphology of the evaporated CdS films will be analyzed by transmission electron microscopy (TEM).

5. Importance of study/ Society applications:

Thin films science and technology plays an important role in the high-tech industries. The demand for development of smaller and smaller devices with higher speed in new generation of integrated circuits requires advance materials and new processing techniques suitable for future technology. In this regard, Physics and technology of thin films can play an important role to achieve this goal.

Thin films occupy a prominent place in basic research and solid state technology. The use of thin film semiconductors has attracted much interest in an expanding variety of applications in various electronic and optoelectronic devices due to their low production costs.

Cadmium sulfide (CdS) is one of the most promising II–VI compound materials because of its wide range of application in various optoelectronic, piezo-electronic and semiconducting devices. The thin films of CdS are of considerable interest for their efficient use in the fabrication of solar cells. In recent years, nanocrystalline thin films of different (II–VI) compound semiconductors have been widely synthesized and studied.

Nanocrystalline thin films are also polycrystalline in nature but with sizes of crystallites of the order of a few nanometres. A major research goal of recent years is to understand the size dependent properties of nanocrystalline materials and as a result considerable amount of work on synthesis and characterization of nanocrystalline thin films are being carried out.

Cadmium sulfide (CdS) plays an essential role in the creation of junctions, buffers, or passivation layers in thin-film photovoltaic (PV) devices. The best device performance has historically been achieved with solar cells incorporating CdS films grown by evaporation method, rather than CdS films grown by using any other method.

Cadmium sulfide (CdS) thin film finds number of applications. Some of them are:

i) It is used as a window layer in solar cell.

ii) Multilayer LED's.

iii) Optoelectronic Devices.

iv) Optical Fibres.

v) Optical IC's such as Photodiodes.

vi) Active electronic device such as hetero-junction diode.

6. Significance of the study:

Increasing world population and demands of utilization of natural resources causes serious problems of energy crises in near future. All the reservoirs of fossil fuels, coal, oil and natural gases are going to exhausts at the end of century. The world has to face the problems of energy crises. These are due to mainly two reasons: firstly the population of the world has increased rapidly and secondly the living standard of human beings is increased. So the human role has to hunt for the new source of energy.

The sun is the ultimate biggest source of energy holding key to resolve the energy crises arising out of growing rift between our energy consumption and production. The solar energy has greatest potential of all the sources of renewable energy. The conversion of solar energy into usable form is potential challenge to the scientists.

7. Proposed work Plan / Formulation and Structure of Study:

It is proposed to synthesis of CdS thin films doped with different elements like Tin (Sn), Lead (Pb), Zinc (Zn) and Lanthanum (La) etc. using the evaporation method and spray pyrolysis technique. We planned to characterize synthesized thin films morphologically, optically and electrically.

Year-wise Plan of work and targets to be achieved:

Sr. No.	Academic Year	Year-wise Plan
1	2019 – 2020	• Data Collection. • Study of related literature. • Submitting FIRST six-monthly report. • First phase of practical work. • Submitting SECOND six-monthly report. • Attending Conferences on related work.
2	2020 – 2021	• Second phase of practical work. • Submitting THIRD six-monthly report. • Statistical analysis of data • Publication of Papers in Physics Journals. • Submitting FOURTH six-monthly report. • Attending Conferences on related work.
3	2021 – 2022	• Submitting FIFTH six-monthly report. • Attending Conferences on related work. • Publication of research papers in Journals. • Attending Conferences on related work. • Submission of synopsis to SRTMU, Nanded. • Submission of Thesis.

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